CLAIMS

1. A container such as a bottle or flask, made heterogeneously from a material with a barrier effect and a polymer material, ~~characterised in that~~ wherein the material with a barrier effect is an amorphous carbon material with a polymer tendency which is applied as a coating on a substrate of polymer material.

2. A container as claimed in claim 1, ~~characterised in that~~ wherein the material with a barrier effect is a nano-composite based on amorphous carbon with a polymer tendency.

3. A container as claimed in claim 2, ~~characterised in that~~ wherein the material with the barrier effect is a nano-composite based on an amorphous carbon with a polymer tendency incorporating metal atoms.

4. A container as claimed in ~~any one of the preceding claims~~, claim 1 ~~characterised in that~~ wherein the coating of material with the barrier effect is less than about 3000 Å thick.

5. A container as claimed in claim 4, ~~characterised in that~~ wherein the coating of material with a barrier effect is between 50 and 1500 Å thick.

6. A container as claimed in ~~any one of the preceding claims~~, claim 1, ~~characterised in that~~ wherein the polymer material is a polyolefin or a polyester, in particular PET or PEN.

7. A container as claimed in ~~any one of the preceding claims~~, claim 1 ~~characterised in that~~ wherein the coating of material with a barrier effect is applied to the substrate inside the container.

8. A container as claimed in ~~any one of claims 1 to 6, characterised in that~~ claim 1 wherein the coating of material with a barrier effect is applied to the substrate on the

exterior of the container.

9. A method using a plasma excited by an electromagnetic wave to form a container, such as a bottle or flask, made heterogeneously from a material with a barrier effect and a polymer material forming a substrate conforming to the shape of said container to be produced, characterised in that said polymer material forming the substrate is coated with a material with a barrier effect comprising an amorphous carbon material with a polymer tendency, consisting of the following steps:

- a blank of the container (18) made from a polymer material forming the above-mentioned substrate is placed in an enclosure (2), in which a high vacuum is created,
- at least one carbon precursor is injected into the reaction chamber (2, 18) in the gaseous state at a very low pressure, the precursor being selected from the alkane, alkene, alkyne and aromatic compounds or a combination of some of them,
- a microwave in the UHF range is simultaneously electromagnetically excited in the reaction chamber, at a relatively low power sufficient to generate a plasma under temperature conditions which will maintain the polymer at a temperature below the glass transition temperature on the one hand and which will cause an amorphous carbon material with a polymer tendency to be deposited on the other.

10. A method as claimed in claim 9, ~~characterised in that~~ wherein the container blank (18) made from polymer material is closed whilst the gaseous carbon precursor is being injected into the enclosure (2) onto the exterior of the blank, the volume between the enclosure and the exterior of the blank constituting the reaction chamber, whereby the coating of amorphous carbon material with a polymer

tendency is formed on the external surface of the container blank.

11. A method as claimed in claim 9, ~~characterised in that~~ wherein the gaseous carbon precursor is introduced into the container blank (18) made from polymer material, which then constitutes the reaction chamber, at the same time as a pronounced vacuum is created inside the container blank, whereby the plasma is formed in the interior of the blank only and the coating of amorphous carbon with a polymer tendency is deposited on the internal surface of the container blank, and a vacuum is simultaneously created in the enclosure in order to reduce the pressure differential between the interior and the exterior of the blank.

12. A method as claimed in claim 11, ~~characterised in that~~ wherein the enclosure (2) is of a transverse dimension close to that of the body of the container blank (18) so as to conform closely to the container blank in order to make it easier to create a vacuum in the enclosure.

13. A method as claimed in ~~anyone of claims 9 to 12, characterised in that~~ claim 9, wherein the gaseous carbon precursor is injected at a pressure of less than 1 mbar.

14. A method as claimed in ~~any one of claims 9 to 13, characterised in that~~ claim 9, wherein before the internal coating of amorphous carbon material with a polymer tendency is formed, an oxygen plasma is formed inside the container blank (18) conducive to generating native oxygen in order to clean the container blank.

15. A method as claimed in ~~anyone of claims 9 to 13, characterised in that~~ claim 9, wherein before the internal coating of amorphous carbon material with a polymer tendency is formed, a bactericidal agent is atomised inside the container blank (18), after which an oxygen plasma is formed,

whereby the plasma generates a highly reductive medium

conducive to reducing bacterial contamination.

16. An apparatus which uses a plasma excited by electromagnetic wave to form a container, such as a bottle or flask, made heterogeneously from a material with a barrier effect and a polymer material forming a substrate (container blank (18)) having the shape of said container to be produced, this apparatus comprising a plasma-generating device with an enclosure (2) fitted with means (7) for injecting a gaseous precursor and electromagnetic excitation means (8-12), ~~characterised in that~~ wherein in order to coat said polymer material forming the substrate with a material having a barrier effect comprising an amorphous carbon material with a polymer tendency, the means (7) for injecting the precursor are connected to a means for generating a precursor in the gaseous state, selected from the alkane, alkene, alkyne and aromatic compounds or a combination of some of them, and injection means are designed to deliver the gaseous precursor at a very low pressure, and the electromagnetic excitation means (8-12) are of a sufficient rating to generate microwaves in the UHF range.

17. An apparatus as claimed in claim 16, ~~characterised in that~~ wherein the enclosure (2) is of dimensions substantially larger than those of the container blank (18) to be treated and in that the injection means open into the enclosure (2) outside the container blank (18), whereby, the container blank being closed, the apparatus generates a plasma outside the container blank and it is on the external surface of the container blank that the coating of amorphous carbon material with a polymer tendency is deposited.

18. An apparatus as claimed in claim 16, ~~characterised in that~~ wherein the means (7) for injecting the gaseous precursor opens into the inside of the container

blank (18) placed inside the enclosure (2), in that it is provided with pumping means (6) opening into the container blank (18) and capable of generating a pronounced vacuum therein, as a result of which the plasma is generated inside the container blank which constitutes a reaction chamber and it is on the internal surface of the container blank that the coating of amorphous carbon material with a polymer tendency is deposited,

and wherein ~~in that~~ the pumping means (6) are also arranged so as to generate a vacuum in the enclosure (2) simultaneously in order to reduce the pressure differential between the interior and the exterior of the blank.

19. An apparatus as claimed in claim 18, ~~characterised in that~~ wherein the enclosure (2) is provided with a removable cover (4) providing a sealed closure designed to support the injector (7) of the means for injecting the gaseous precursor and the suction orifice (5) of the pumping means.

and ~~in that it~~ wherein said apparatus also has means (17) designed to support a container blank (18) by the neck thereof, applying the lip (23) of said container blank in a tight seal against the internal face (22) of said cover, surrounding said suction orifices and the injector.

20. An apparatus as claimed in claim 19, characterised in that the support means (17) can be axially displaced (19) in order to apply the container blank against the internal face of the cover (4) capping said suction orifices and injector prior to depositing the coating or to remove the finished container therefrom after the coating has been deposited.

21. An apparatus as claimed in claims ~~16 to 20,~~ claim 16, wherein ~~characterised in that~~ the microwave excitation means comprise a waveguide (8) radially connected to a cavity

(1) surrounding the enclosure (2), said cavity (1) being provided with transverse short-circuit means (10).

22. An apparatus as claimed ~~in any one of claims 18 to 21, characterised in that~~ claim 18, wherein the enclosure (2) is of a transverse dimension close to that of the body of the container blank (18).

23. An apparatus as claimed ~~in any one of claims 16 to 20, characterised in that~~ claim 16, wherein the microwave excitation means comprise antenna (13) connected to a waveguide (15) and disposed radially in a cavity (1) surrounding the enclosure (2), said cavity (1) being provided with longitudinal short-circuit means (11).

24. An apparatus as claimed ~~in any one of claims 16 to 20, characterised in that~~ claim 16, wherein the microwave excitation means comprise an antenna (13) connected to a waveguide (15) and coaxially disposed in a cavity (1) surrounding the enclosure (2), said cavity (1) being provided with longitudinal short-circuit means (11).

ADD 03

ADD 02